

**THE FOLLOWING IS THE ENGLISH TRANSLATION OF THE
2nd ARTICLE 34 AMENDMENT (Pages 18-20, 20/1, 40-43, and 47-48)**

separated in time at random to create a time-hopping pattern.

The receiver circuit 20 shown in Fig. 4 correlates with a template waveform and identifies a pulse signal.

In the present invention, ultra-wideband transmission circuits and wideband transmission antennas are integrated on a silicon substrate using the techniques described above. An electromagnetic wave signal is transmitted from the silicon substrate using the techniques described above. An electromagnetic wave signal is transmitted from the silicon substrate and received with receiver antennas integrated on a plurality of other silicon substrates, whereby a pulse signal is identified.

A second embodiment (corresponding to Claim 2 or 3) of the present invention will now be described.

Fig. 5 is a sectional view of a semiconductor device according to the second embodiment of the present invention.

In this figure, reference numeral 41 represents a Si substrate, reference numeral 42 represents a first interlayer insulating layer (a low dielectric constant and a relative dielectric constant of 2.0) surrounding metal wiring layers including multilayer wires, reference numeral 43 represents the metal wiring layers, reference numeral 44 represents a second interlayer insulating layer (a high dielectric constant and a relative dielectric constant of 7.0), reference numeral 45A represents the transmitting

antenna, reference numeral 45B represents the receiving antenna, reference numeral 46 represents reflectors, and reference numeral 47 represents an antenna layer.

In this embodiment, in order to reduce the interference between the antennas 45 (the transmitting antenna 45A and the receiving antenna 45B) and the metal wiring layers 43, the antenna layer 47 is spaced from the metal wiring layers 43. The standard of the spacing is as described below.

In order to prevent electromagnetic waves transmitted from the transmitting antenna 45A from interfering with metal wiring layers 43, it is necessary to find conditions for totally reflecting the electromagnetic waves from the interface between the second interlayer insulating layer 44 and the first interlayer insulating layer 42 surrounding the metal wiring layer 43. Furthermore, it is necessary that the metal wiring layers 43 are not arranged in regions that do not satisfy total reflection conditions.

Therefore, the metal wiring layers 43 which include the multilayer wires made of copper are arranged in the low-dielectric constant interlayer insulating layer 42 having a relative dielectric constant of 2.0, which is placed on the Si substrate 41, and the antennas 45 are insulated with the high-dielectric constant interlayer insulating layer 44 having a dielectric constant of 7.0. The transmitting antenna 45A is placed in a portion of the antenna layer 47

and the metal wiring layers 43 are arranged in the low-dielectric constant porous silica (first insulating layer) 42 having a dielectric constant of 2.0 in such a manner that top and bottom of the metal wiring layer are covered thereby.

The second interlayer insulating layer 44 is made of silicon nitride, formed by a plasma-enhanced CVD (chemical vapor deposition) process, and has a dielectric constant greater than that of the first interlayer insulating layer 42 adjacent thereto. A region that satisfies conditions for totally reflecting the electromagnetic waves from the interface between the first interlayer insulating layer 42 and the second interlayer insulating layer 44 is determined by below equations that describe the relationship between the distance x from the antennas 45 to the metal wiring layers 43 and the thickness t of the second interlayer insulating layer 44. The reflectors 46 are arranged on the same plane of the antenna layer 47 in the direction opposite to the transmission direction.

$$\text{Total Reflection Angle} = \sin^{-1} \sqrt{\frac{\text{Dielectric Constant of First Insulating Layer}}{\text{Dielectric Constant of Second Insulating Layer}}} \quad (1)$$

$$\text{Total Reflection Angle} = \tan^{-1} \sqrt{\frac{\text{Distance from Antennas to Wires}}{\text{Thickness of Second Insulating Layer}}} \quad (2)$$

This configuration is effective in improving the antenna gain of the semiconductor device.

The configuration with which the antenna gain of the semiconductor improve and manufacturing steps thereof will now be described with reference to Figs. 6 and 7.

CLAIMS

1. (Amended) A semiconductor device characterized in that an electromagnetic wave transmission signal is transmitted from a transmitting antenna placed on a semiconductor substrate to a receiving antenna placed on the semiconductor substrate such that wireless interconnection is accomplished, the semiconductor substrate has a broadband transmitting/receiving antenna respectively, a signal is transmitted from the semiconductor substrate and received with the receiving antenna of the semiconductor substrate, the signal transmitted and received has an ultra-wideband communication function, multilayer wires (43) are arranged in a first interlayer insulating layer (42) placed on a semiconductor substrate (41), a second interlayer insulating layer (44) is placed on the first interlayer insulating layer (42), an antenna layer (47) is placed on the second interlayer insulating layer (44) and has a transmitting antenna (45A) and a receiving antenna (45B), the second interlayer insulating layer (44) has a dielectric constant different from that of the first interlayer insulating layer (42) so as to satisfy the condition that an electromagnetic wave is totally reflected from the interface between the first and second interlayer insulating layers, and reflectors (46) are arranged in the antenna layer (47) and

each located behind the transmitting antenna (45A) and the receiving antenna (45B).

2.

3.

4. (Canceled)

5. (Canceled)

6.

7.

13. (Amended) A semiconductor device characterized in that an electromagnetic wave transmission signal is transmitted from a transmitting antenna placed on a semiconductor substrate to a receiving antenna placed on the semiconductor substrate or receiving antennas placed on a plurality of semiconductor substrates such that wireless interconnection is accomplished, the semiconductor substrates are arranged so as to achieve multilayer integration, and a transmitting/receiving antenna placed on the semiconductor substrate is placed on the same side as that on which the transmitting antenna is placed and serves as a relay for an electromagnetic wave transmission signal radiated from the transmitting antenna.

14.

15. (Amended) The semiconductor device according to Claim 13, wherein the maximum time obtained by dividing the distances between the transmitting and receiving antennas by the electromagnetic wave transmission speed is less than one fourth of a clock period of the electromagnetic wave transmission signal.